WHAT IS CLAIMED IS:

1. Apparatus useful for purifying a gas stream, comprising

(a) a shell-and-tube heat exchanger comprising a shell inlet and a shell outlet in fluid communication with the shell inlet, and further comprising a plurality of tubes each having an inlet and an outlet;

(b) a catalyst system comprising a catalyst supported on a monolithic unitary support having passages therethrough, the support having a length and upstream and downstream ends at opposite ends of the length, wherein the diameter of said support is from one-half to two times the diameter of the shell of the heat exchanger, and wherein the downstream end of said support is connected in fluid communication with the inlets of said tubes by a passageway whose length does not exceed the length of the support and whose diameter is at no point less than the smaller of the diameter of said support and the diameter of said shell; and

(c) a source of gas to be purified in fluid communication with said upstream end of said support.

2. Apparatus according to claim 1 wherein the first outlet of the heat exchanger is connected in fluid communication to the upstream end of the catalyst support.

3. A method for purifying a gas stream comprising a principal component and at least one impurity, comprising providing apparatus according to claim 1, wherein the

catalyst is capable of catalyzing reaction of at least one impurity in said gas stream, passing the gas stream into the upstream end of the catalyst of said apparatus under conditions effective to remove one or more impurities from said gas stream whereby said at least one impurity in said gas stream is catalytically converted to a byproduct, and removing heat from said gas stream by passing said gas stream from the downstream end of said catalyst into the second inlet and out of the second outlet of said heat exchanger.

4. The method of claim 3 further comprising heating said gas stream by passing it into the first inlet and out of the first outlet of said heat exchanger and then into the upstream end of said catalyst.

5. The method of claim 3 wherein the main component of said gas stream is carbon dioxide, said gas stream comprises one or more hydrocarbons as impurities, and said method removes hydrocarbons from said gas stream.

6. The method of claim 3 wherein the main component of said gas stream is argon, said gas stream comprises oxygen as an impurity, and said method removes oxygen from said gas stream.

7. The method of claim 3 wherein the main component of said gas stream is helium, said gas stream comprises hydrogen as an impurity, and said method removes hydrogen from said gas stream.